TEXAS AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 183 DECEMBER, 1915

DIVISION OF CHEMISTRY

Moisture Relations of Some Texas Soils

POSTOFFICE
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
Von Boeckmann-Jones Co., Printers
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BY

G. S. FRAPS, Ph. D.
Chemist in Charge; State Chemist

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*As of December 1, 1915.
**In Cooperation with the United States Department of Agriculture.

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MOISTURE RELATIONS OF SOME TEXAS SOILS

BY G. S. FRAPS, Ph. D., CHEMIST IN CHARGE; STATE CHEMIST.

Soil moisture is an exceedingly important controlling condition for Texas crops. There are times when the rainfall is excessive and the crops suffer from too much moisture, and in limited sections of the State this condition occurs often. In most sections, the crops suffer more often from too little moisture, and the yield is cut short on account of deficiency of water. This is particularly the case with corn; a dry period at the time of tasseling, in one section of the State or another, cuts short the production of grain almost yearly. Corn is a shallow rooting crop and suffers more frequently from lack of moisture than cotton. Cotton sends down a deep tap root, and can withstand dry weather, as it takes moisture from the depths of the soil.

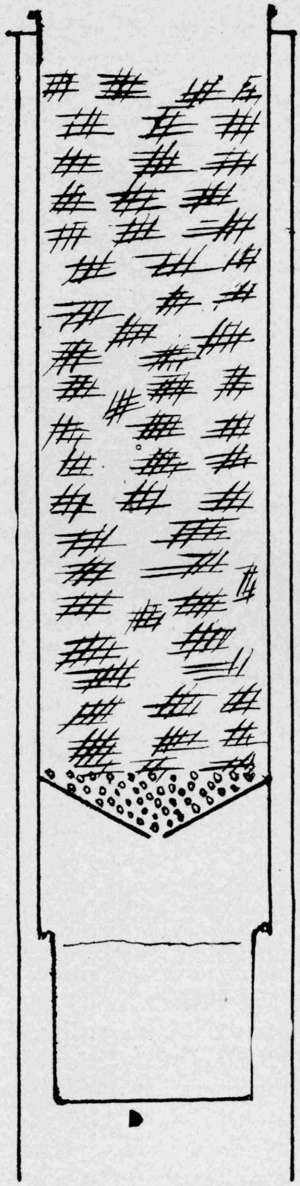
Soil moisture is, to a certain extent, susceptible to control. Fall plowing, in some soils, opens them up and allows the water and air to penetrate and be absorbed by the soil. Shallow cultivation decreases the loss of moisture by evaporation. Cultivation at the right time has often increased the corn crop, or saved a crop that would have been lost by drouth. Vegetable matter makes the soil more porous, more easily penetrated by water, and more retentive of moisture and allows the roots to touch more easily the moisture-laden soil particles. Lime is needed on some heavy clay soils, to allow water to penetrate more easily and to allow air to enter and the roots to penetrate. Drainage opens channels for air and roots, drains off the surplus moisture, and by allowing the roots to go deeper into the soil, permits the utilization of much larger stores of soil moisture.

All these methods, properly applied according to the needs of the particular soil under cultivation, assist in holding soil moisture, or bringing the roots into possession of that already there. Deep penetration of plant roots is an important requisite for good crops in sections liable to suffer from dry weather.

In Bulletin No. 171 of this station we reported studies of soil moisture conditions in Texas soils, as ascertained by percolation experiments, in which the quantities of water which percolated through pots of the soils were measured. This method of experiment does not show the quantities of water contained in the soil at various intervals. The percolation is affected, to a considerable extent, by the relative moistness of the soil. The experiments reported in the present bulletin were designed to supplement the other work, by showing the condition of moisture of the soils at various intervals.

PLAN OF EXPERIMENT.

The soil, dry and pulverized, was placed in cans six inches in diameter, on top of a layer of gravel which filled the funnel in the bottom



Scale 6"

Fig. A

of the can. The cans were weighed, saturated with distilled water, again weighed, and placed out in an outer casing, which had been previously imbedded in the soil, so as to project about one inch above it. Figure A gives the dimensions of the can, the outer casing, and the bucket for collecting the percolating water. As some of the soils expanded on wetting, the soil later on was removed to a depth of two inches from the top of the can, dried, weighed, and the weight deducted from the original soil. Additions and cultivations were then made to the pots according to the plan given in Table 1.

TABLE 1.—TREATMENT OF SOILS.

Can No.	Soil No.	Treatment.	Pot No.	Soil No.	Treatment.
1........	1956	Not cultivated..	16	1580	Cultivated 2″, 18 gm. excrement.
2........	"	Cultivated 1″..	17	3335	Not cultivated.
3........	"	Cultivated 2″..	18	"	Cultivated 2″.
4........	"	Cultivated 4″..	19	"	Cultivated 2″, 12 gm. excrement.
5........	"	Cultivated 6″..	20	3341	Not cultivated.
6........	"	Cultivated 2″, 4 gm. carbonate of lime..............	21	"	Cultivated 1″.
7........	"	Cultivated 2″, 12 gm. excrement.....................	22	"	Cultivated 2″.
8........	"	Cultivated 2″, { 12 gm. excrement....... 4 gm. carbonate of lime.	23	"	Cultivated 4″.
9........	1577	Not cultivated..	24	"	Cultivated 6″.
10........	"	Cultivated 2″..	25	"	Cultivated 2″, 12 gm. excrement.
11........	1580	Not cultivated..	26	"	Cultivated 2″, 18 gm. excrement.
12........	"	Cultivated 2″..	27	"	Cultivated 4″, 12 gm. excrement.
13........	"	Cultivated 4″..	28	3333	Not cultivated.
14........	"	Cultivated 6″..	29	"	Cultivated 2″.
15........	"	Cultivated 2″, 12 gm. excrement.....................	30	"	Cultivated 2″, 4 gm. carbonate of lime.

The period of observation began May 1, 1911, and ended January 1, 1913, covering nearly two years. A large number of weighings and observations were made during this period, but it is unnecessary for the purpose of this discussion, to record the entire mass of data. Curves are presented elsewhere in the bulletin, for certain of the soils, which record the data in detail.

The weighings were, at times, affected by the wind, as they were made out of doors. Due allowance has been made for this wherever necessary and so far as possible.

The rainfall, by days, for the period of observation is given in Table 2.

TABLE 2.—RAINFALL IN INCHES, 1911.

Days of Month.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1			0.33					
2	0.98		.03		.07			
3	0.07				.08		.01	
4			.02		.01			
5								
6			1.14					.60
7			.09			.03	.45	.06
8			.82				1.11	.02
9							.01	
10				.20			.02	1.88
11				.08		.16		.01
12	1.29					1.83	.01	
13			.11			.53		
14			.01	1.25				.75
15			.17					.58
16			.05			.16		
17			.16				.16	
18			2.74	.06				
19		.14						1.15
20	.03							.24
21	.31	.20				.28		
22		.04			.03	.01		.12
23					.41		.07	.20
24				.10	.24			.02
25				1.78				.20
26	.01							.47
27				.12			.03	
28	.01			.05				
29					.75	.06		.74
30					.02	.47		.21
31						.02		
Total	2.70	.38	5.67	3.64	1.61	3.55	1.87	7.25

TABLE 2 RAINFALL IN INCHES, 1912—Continued.

Days of Month.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1				.10		.37			.15			Tr.
2			.02		.47	.27	.19					.02
3			.02		Tr.	.03		.02	.09			1.29
4			.01		.89							.30
5			1.60		.01	.34						.10
6	.04			Tr.	.42	.08		.01				
7	.01		.02	1.49								
8	.02		.05	.10								.04
9			Tr.	.15								.09
10				.03	.06							.24
11	.61		.23									1.01
12	.05			.10								.35
13		1.07										.01
14			.43									
15					.27					.13		Tr.
16				Tr.					.26	.76		.01
17						.06	.84		.05	.55		Tr.
18						.82	.02		.48	.08		
19						.10	1.85					
20		.01		.04		.04						.19
21			.09	Tr.					.11		.01	.72
22	.06		2.28				.08	.01		.07	.73	.26
23	.06	.11	.85								Tr.	.44
24		1.33						.16		.04		
25		.01		Tr.				.01			.12	
26				Tr.							Tr.	
27	.02		Tr.								.05	
28	.05		.92	.10		.10						
29					2.00							
30										Tr.		
31			.06							.01	.01	
Total	.92	2.53	6.58	2.11	4.12	2.21	2.98	.21	1.14	1.64	.92	5.33

DESCRIPTION OF SOILS.

The soils used are described below. Table 3 shows their chemical composition:

3341. Yazoo clay; from McLennan county; six miles east of Waco. Very good soil; bottom land, but not subject to overflow. Produces one-half bale of cotton, 45 bushels corn, and 40 to 50 bushels oats.

3335. Houston black clay; depth 0-12 inches. Very good land. From Waco, McLennan county. Produces one-half bale of cotton and 35 bushels of corn. Packs, dries into clods, and does not wash; dirt does not wash onto it; sticky.

3333. Houston loam; depth 0-10 inches. Four and one-half miles from Waco, McLennan County. Good soil, upland, rolling prairie. Suffers from drouth. Produces 25 to 30 bushels of corn and one-fourth to three-fourths bales of cotton.

1956. Sand from E. J. Kyle's farm, between College and Bryan, Brazos county.

1580. Houston black clay loam; depth 0-6 inches. From five miles south on Goliad road, San Antonio, Bexar county. Good uniform land, and produces 50 bushels of corn.

1577. San Antonio clay loam; depth 0-6 inches. From seven miles south of San Antonio, Bexar county. Virgin, poor, rolling, and is slightly gravelly. Produces one-half bale of cotton.

TABLE 3.—COMPOSITION OF SOILS.

	San Antonio Clay Loam, 7 Miles South of San Antonio	Houston Black Clay Loam, 5 Miles South of Goliad.	Sand from Between College and Bryan.	Houston Loam, 4 1-2 Miles from Waco.	Houston Black Clay, from Waco.	Yazoo Clay, 6 Miles East of Waco.
	Surface. 1577	Surface. 1580	Surface. 1956	Surface. 3333	Surface. 3335	Surface. 3341
Percent:						
Phosphoric Acid	....	....	.04	.02	.11	.25
Nitrogen	.03	.11	.03	.03	.12	.15
Potash	.25	.52	.07	.21	.79	.70
Lime	31.92	2.30	.33	.17	3.30	3.09
Magnesia	.55	.58	.06	.17	1.12	.41
Alumina and Oxide of Iron	3.33	8.24	1.01	2.73	11.67	7.59
Insoluble and Soluble Silica	32.95	79.22	98.07	94.84	69.78	75.08
Loss on Ignition	....	....	....	1.49	8.25	....
Moisture	....	....	....	.54	4.60	3.24
Parts Per Million:						
Active Phosphoric Acid	41	84	75	21	38	1117
Active Potash	207	657	106	155	45	998
Acidity	0	11	....	0	0	0
Acid consumed	100	68.7	3.9	3.4	52.9	47.1
Water capacity	34.6	40.7	26.5	28.2	43.8	45.0

CURVES SHOWING RELATIONS.

Curves are here prescribed showing the moisture content of certain of the soil samples. Figures 1, 2 and 3 show the water content of all the soil types for 1911, though not all the treatments given. Figure 1 also shows the rainfall during the period of observation. Figures 4 and 5 show the water content of the fine sandy soil and the Houston black clay for 1912, and Figure 5 also shows the rainfall. As the curves were remarkably similar in appearance, it was not thought necessary to draw them for all the cans or for all the types in 1912. The circles drawn on the curves show the dates of water percolating through the soils.

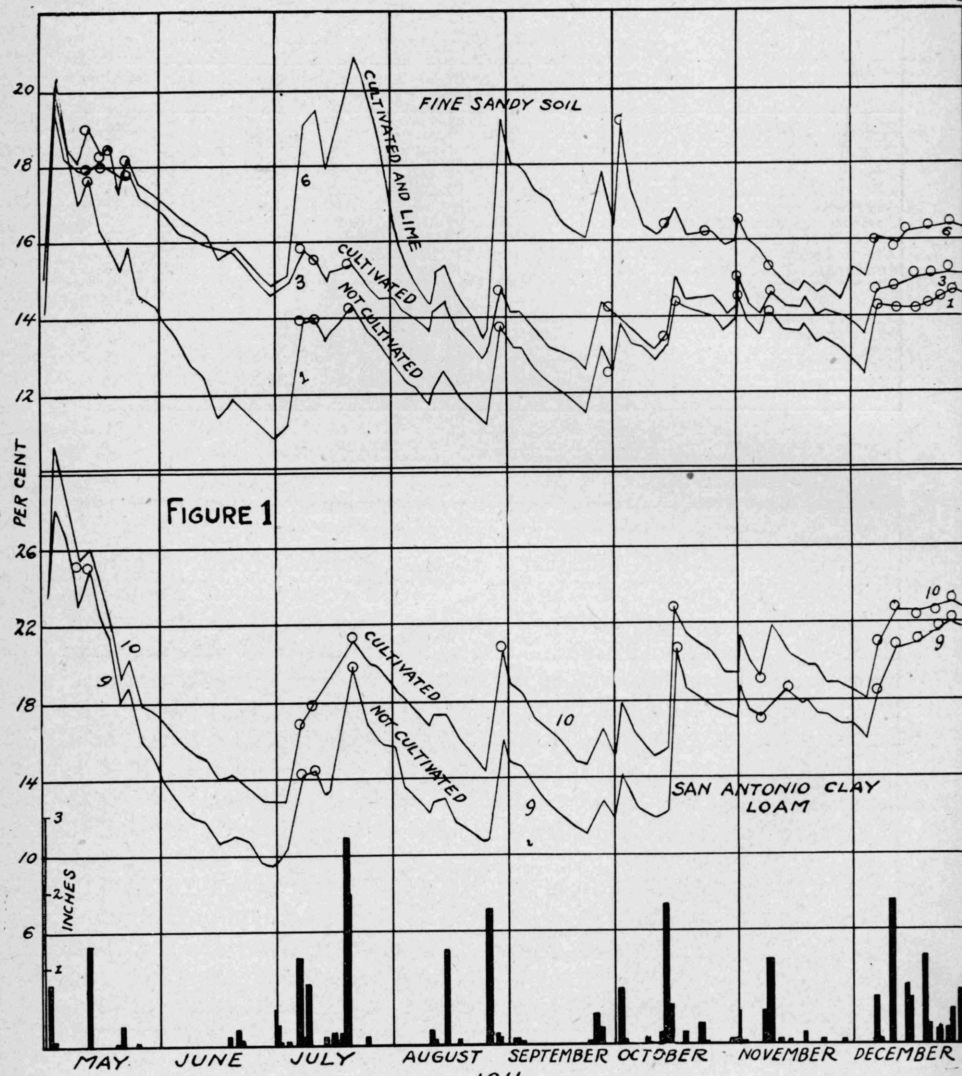


Fig. 1—Water Content of Soils, 1911

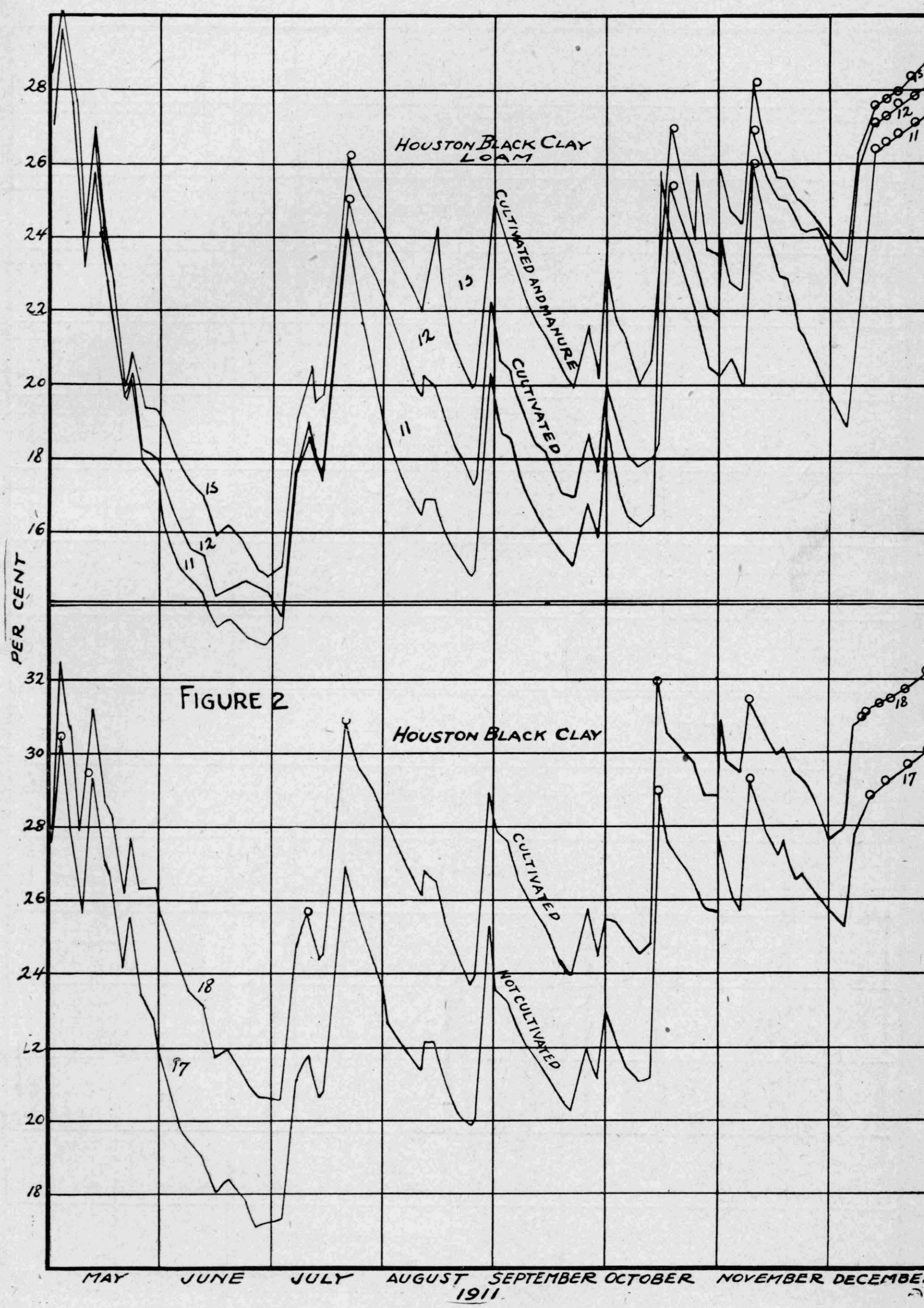


Fig. 2—Water Content of Soils, 1911

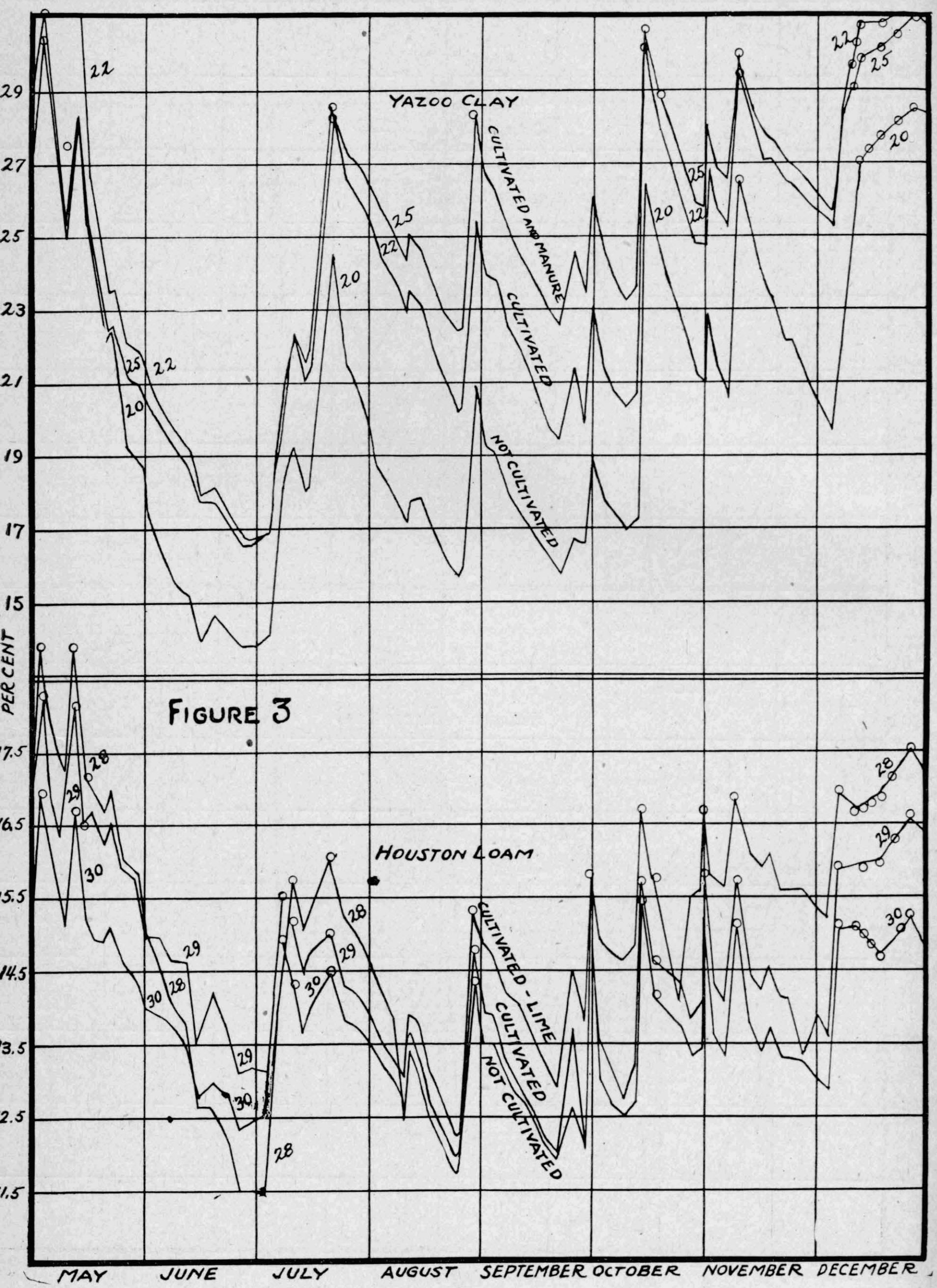


Fig- 3—Water Content of Soils, 1911

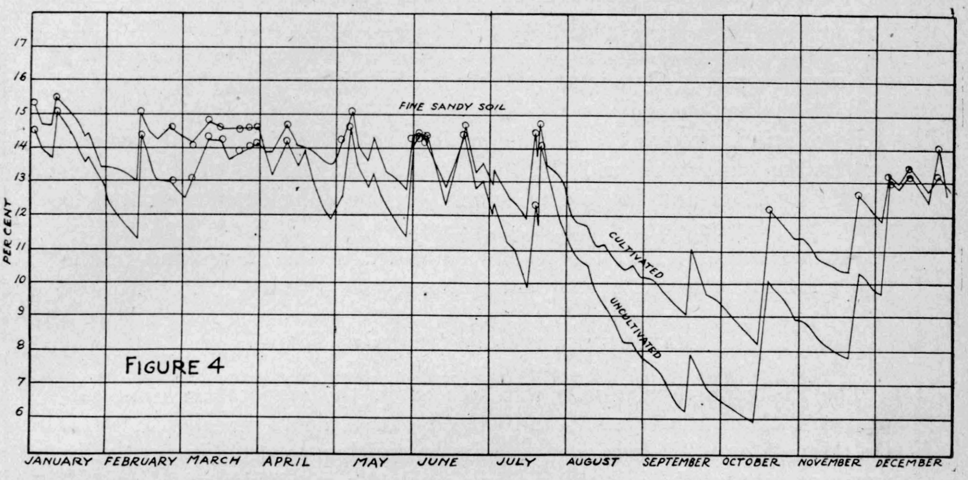


Fig. 4—Water Content of Fine Sandy Soil, 1912

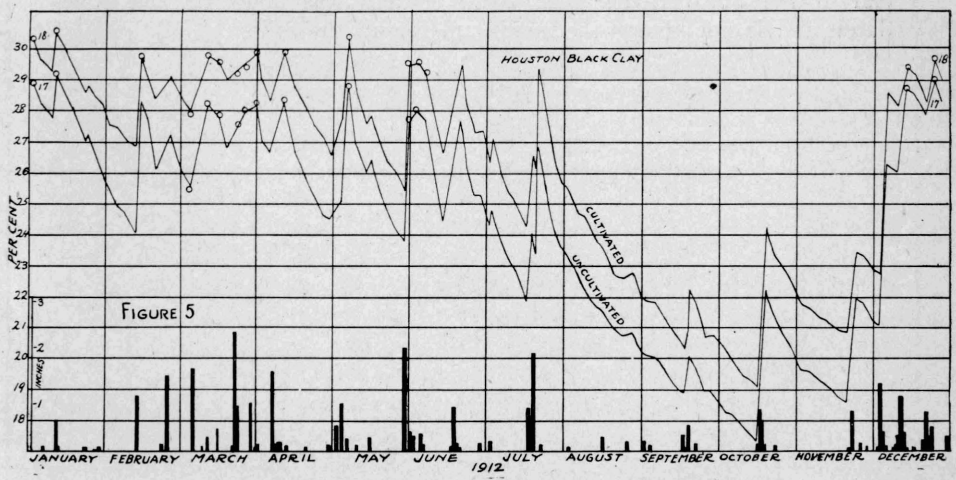


Fig. 5—Water Content of Houston Black Clay, 1912

The curves show clearly the effects of cultivation upon the water content of the soil. The cultivated soil contains a larger percentage of water in practically all cases.

The curves also show the decided drop in water content during the dry periods, and the gain during the wet periods. Figure 1 shows a much more rapid fall in water in the fine sandy soil, during June, 1911, than in the Houston black clay loam. The lime also renders the sandy soil more retentive of moisture. The decided differences in the moisture held by the various soils is also shown.

Percolation through the soil before it is saturated is shown especially by the fine sandy soil and the San Antonio clay loam. The Houston black clay loam and black clay seldom become sufficiently saturated to allow percolation during the crop season.

Further discussicn of the results embodied in the curves and in the tables are given in the subsequent sections.

MAXIMUM WATER CONTENTS OF SOILS.

The finely pulverized soils were placed in the evaporation cans, saturated with distilled water, and placed out of doors on May 1, 1911. On May 2 and 3, there was a rain amounting to 1.05 inches. The water content of the soil at this time reached a maximum with some of the pots that was never again attained, and this is especially noticeable in the case of the sandy soil, No. 1956. The curves bring out this fact clearly. The soils at this time were not under field conditions, so that this water content may be regarded as abnormal.

Table 4 shows the water contents of the soil at the end or near the end of the wet periods. The water content was taken on the same dates, and is not always the maximum for all the soils.

TABLE 4.—PERCENTAGE OF WATER IN SOILS AT ENDS OF WET PERIODS.

Lab. No.	Description.	Pot No.	May 3, 1911	July 10, 1911	July 20, 1911	Dec. 27, 1911	Mar. 11, 1912	Mar. 30, 1912	May 6, 1912	July 20, 1912	Oct. 18, 1912	Dec. 13, 1912	Average (except May 3, 1911)
1956	Not cultivated	1	20.19	13.92	14.37	14.65	14.21	14 04	14.63	13.97	11.80	13.32	13.88
	Cultivated 1″	2	18.80	14.70	14.81	15.04	14.65	14.25	15.04	14.37	12.37	13.24	14.27
	Cultivated 2″	3	19.66	15.46	15.35	15.13	14.57	14.40	14.79	14.57	12.07	13.35	14.45
	Cultivated 4″	4	19.47	15.51	15.40	15.01	14.45	14.12	14.62	14.57	12.82	13.47	14.44
	Cultivated 6″	5	15.58	14.83	14.78	14.85	14.38	13.82	14.66	14.21	12.40	13.60	14.17
	Cultivated 2″, lime	6	19.98	19.36	20.93	16.44	15.49	15.10	15.52	15.24	12.54	13.64	16.03
	Cultivated 2″, exc.	7	20.81	16.25	16.14	15.69	14.74	14.29	14.98	14.41	14.42	13.21	14.85
	Cultivated 2″, exc. lime	8	20.89	16.14	16.03	15.64	14.69	14.53	14.93	14.38	12.18	13.32	14.65
1577	Not cultivated	9	25.00	14.29	19.89	21.98	21.43	21.55	21.83	20.96	16.73	20.08	19.86
	Cultivated 2″	10	23.80	17.93	21.24	23.23	21.91	22.22	22.38	21.61	14.85	20.16	20.61
1580	Not cultivated	11	30.46	18.94	24.30	27.35	27.62	27.42	28.15	23.22	18.32	26.80	24.68
	Cultivated 2″	12	29.54	18.57	24.99	28.20	27.59	27.39	28.45	26.06	19.41	27.03	25.30
	Cultivated 4″	13	30.42	20.44	27.18	30.82	28.18	28.37	29.03	28.00	20.02	27.03	26.56
	Cultivated 6″	14	30.73	19.73	26.87	29.67	27.47	28.13	28.64	27.09	19.05	25.35	25.78
	Cultivated 2″, exc.	15	29.68	20.45	26.30	29.08	27.95	27.56	29.02	26.83	19.87	26.72	25.98
	Cultivated 2″, exc.	16	29.92	20.01	26.73	27.66	28.66	28.46	29.37	27.55	19.99	27.16	26.18
3335	Not cultivated	17	29.26	20.82	25.91	28.88	27.68	27.62	28.19	26.26	21.58	28.14	26.12
	Cultivated 2″	18	31.53	24.58	29.84	31.08	30.10	30.24	29.94	29.72	24.32	29.67	28.83
	Cultivated 2″, exc.	19	29.14	24.99	29.27	29.99	28.26	28.43	27.80	28.70	23.08	28.65	27.69
3341	Not cultivated	20	31.37	19.24	24.58	28.40	28.01	27.68	28.66	25.28	19.28	28.78	25.55
	Cultivated 1″	21	31.33	20.41	27.11	30.39	29.38	29.05	30.67	26.78	19.22	28.68	26.85
	Cultivated 2″	22	34.01	22.25	28.31	31.20	30.70	30.14	31.83	28.85	20.77	29.07	28.12
	Cultivated 4″	23	31.01	21.01	28.16	30.60	29.80	30.13	30.56	29.70	23.36	29.16	28.05
	Cultivated 6″	24	32.42	21.08	27.47	29.12	29.51	31.29	29.75	28.50	19.21	27.49	27.05
	Cultivated 2″, exc.	25	28.53	22.32	28.47	31.02	29.58	29.32	30.06	29.62	24.87	29.19	28.27
	Cultivated 2″, exc.	26	37.36	23.51	30.88	33.00	31.87	31.94	31.12	30.04	26.57	30.56	29.83
	Cultivated 4″, exc.	27	29.59	24.15	29.98	32 18	30.07	30.41	30.51	29.53	22.59	29.29	28.75
3333	Not cultivated	28	18.89	15.72	15.99	17.47	17.19	17.25	17.79	17.14	14.96	16.21	16.66
	Cultivated 2″	29	18.23	15.07	15.01	16.54	16.38	15.29	15.07	18.23	14.19	17.60	15.94
	Cultivated 2″	30	15.56	14.25	14.47	15.18	14.30	15.12	15.07	14.17	12.66	13.48	14.34

It will be noted that the water content of several of the soils on May 3, 1911, is greater than at any subsequent period. This is particularly marked with the fine sandy soil, No. 1956. With certain of the other soils, the maximum water content approaches this quantity, and in a few cases even exceeds it, which is the case with Yazoo clay, No. 3341. We conclude from these observations that the stirring and pulverization which preceded the introduction of the soil into the pot, in most cases, increased its capacity to retain water, which water-holding capacity of the saturated soil became reduced upon the subsequent drying and compacting to which the soil was naturally subjected in the pot.

With the sandy soil, No. 1956, there is noted a tendency toward a decreased water-holding capacity of the soil. However, this may be partly due to the fact that the soil dried out very much in the latter part of 1912, and required some time to again become fully saturated and had not reached the condition of saturation when the observations were discontinued. As will be shown later on, water percolates through these soils before they are fully saturated.

TABLE 5.—WATER IN SOILS AT ENDS OF WET PERIODS AND WATER CAPACITY

Lab. No.	Description of Soil.	Water Capacity.	Average Per cent Water.	Per cent of Water Capacity.	Maximum Per cent Water.	Per cent of Water Capacity.
1956	Sandy soil...............	26.5	13.88	52.	14.65	55.
1577	San Antonio loam.........	34.6	19.86	57.	21.98	64.
1580	Houston black clay loam..	40.7	24.68	61.	28.15	69.
3335	Houston black clay.......	43.8	26.12	60.	28.88	66.
3341	Yazoo clay...............	45.0	25.55	57.	28.66	64.
3333	Houston loam.............	28.2	16.66	59.	17.79	63.
	Average.............	36.5	21.12	58.	23.35	64.

Table 5 shows the average water content of the soils at the ends of wet periods and the water capacity of the soil, together with the per cent. of the water capacity held by the soil. We determine the water capacity by placing 50 grams soil in one and one-half-inch carbon funnel, saturating with water, and weighing after the excess of water has dripped through. The average water held by the six soils is 58 per cent. of the water capacity. The maximum percentage of water found in the soil (exclusive of that on May 3, for the reasons already given) is also presented in Table 5. The quantity is not widely different from the average found at the ends of the wet periods. We must note that the soil never approaches the condition of saturation reached in the laboratory, even after continued rains, the maximum found being 69 per cent.

According to Briggs et al., Bulletin No. 230, Bureau of Plant Industry, the amount of water in the soil at the time of the wilting of certain crops, is equal to the water-holding capacity of the soil minus 21 divided by 2.90. This calculation is probably only approximately correct.

TABLE 6.—AVAILABLE WATER OF SATURATED SOILS. (PER CENT.)

Lab. No.	Description of Soil.	Wilting Point.	Average Percent Water.	Available Water.	Bu. Corn Equivalent of Available Water.	Maximum Water.	Available of Maximum.
1956	Sandy soil................	1.9	13.9	12.0	12.6	14.7	12.8
1577	San Antonio clay loam.....	4.7	19.9	15.2	15.9	22.0	17.3
1580	Houston black clay loam...	6.8	24.7	17.9	18.8	28.2	21.4
3335	Houston black clay........	7.9	26.1	18.2	19.1	28.9	21.0
3341	Yazoo clay................	8.3	25.6	17.3	18.1	28.7	20.4
3333	Houston loam..	2.5	16.7	14.2	14.9	17.8	15.3

Table 6 shows the wilting points and the available water, calculated by this method, based upon the maximum saturation and upon the average water content at the ends of the wet periods. It will be noted that there is considerable variation in the available water held by the different soils. This fact is brought out still more clearly when we express the percentages in terms of bushels of corn which this quantity of water would be able to produce. In making this calculation, we assume that one bushel of corn requires 38,000 pounds of water for the production of leaves, stalk, cob, and grain and that all of the water goes towards the production of the corn, none being lost by evaporation.

With a soil depth of 14 inches, which would usually weigh four million pounds per acre, 1 per cent. of water would be equivalent to 1.05 bushels of corn, or 13 pounds of lint cotton, or 0.7 bushels of wheat, or 1.5 bushels of oats, or 130 pounds of hay. According to these calculations, the soils in the average wet condition after heavy rains, Table 6, retained enough water, to a depth of 14 inches, for from 12.6 to 19.1 bushels of corn, or from 156 to 234 pounds of cotton lint, the quantity held varying with the nature of the soil. The plant draws moisture from a greater depth of soil than 14 inches, but, on the other hand, there is a considerable loss of water by evaporation. For a crop of 60 bushels of corn, the roots of the plant must draw water from a depth of 56 to 70 inches, if we exclude both rainfall and evaporation during the crop season.

THE EFFECT OF CULTIVATION AND MANURE UPON WATER HELD BY THE SATURATED SOIL.

Table 3 shows the water content at the ends of the wet periods of the ten pots receiving different treatments. The average results are summarized in Table 7. The effect of cultivation is uniformly to increase the quantity of water retained by the soil. The soils cultivated to the depth of four inches in two cases retain less and in one case retains more than the soil cultivated to the depth of two inches. Cultivation to the depth of one inch makes the soil less retentive than the cultivation to the depth of two inches in two cases. The addition of lime increases the retention of water in one case and decreases it in

TABLE 7.—AVERAGE WATER CONTENT AT ENDS OF WET PERIOD.

Lab. No.	Description of Soil.	Not Cultivated.	Cultivated 1″	Cultivated 2″	Cultivated 4″	Cultivated 6″	Cultivated 2″, lime.	Cultivated 2″, exc.	Cultivated 2″, exc.	Cultivated 4″, exc.	Cultivated 1 1-2″, exc.
1956	Sandy soil	13.88	14.27	14.45	14.44	14.17	16.03	14.85	14.65	....	....
1577	San Antonio clay loam	19.86	....	20.61	....	....	....	....	....	....	....
1580	Houston black clay loam	24.64	....	25.30	26.56	25.78	....	25.98	26.18	....	....
3335	Houston black clay	26.12	....	28.33	....	....	....	27.69	....	....	....
3341	Yazoo clay	25.55	26.85	28.12	28.05	27.05	....	28.27	....	28.75	29.83
3333	Houston loam	16.66	....	15.94	....	....	14.34	....	....	....	....

the other. The addition of excrement increases the retention of the water in three of the four instances. The increase in quantity of excrement added in one case caused an increase in the retention of water.

The differences are not large, but are sufficient to indicate that the stirring and the addition of manure makes the soil slightly more retentive of water at the ends of wet periods, even when it is in what may be termed a field saturated condition. Undoubtedly, under field conditions, the stirred soil has the further advantage of holding the water from flowing off, until a portion of it has had time to penetrate. On a hard, untilled soil, water may flow off long before the soil has absorbed much water. This is particularly the case when the rains are heavy, as under the climatic conditions of the South.

WATER AT END OF DRY PERIODS.

Table 8 shows the percentages of water at or near the ends of various dry periods. Some of these dry periods were short, while others were of long duration. The minimum water content in 1911 was reached on September 21, and the minimum water content in 1912 was reached on October 14.

TABLE 8.—PERCENTAGE OF WATER IN SOIL AT ENDS OF DRY PERIODS.

Lab. No.	Description.	Pot No.	June 29, 1911	Aug. 10, 1911	Sept. 21, 1911	For year Oct.9, 1911	Dec. 5, 1911	Jan. 9, 1912	Feb. 12, 1912	May 30, 1912	June 13, 1912	July 15, 1912	Sept. 16, 1912	For year Oct. 14, 1912	Nov. 19, 1912	Total	Average.
1956	Not cultivated	1	10.90	11.69	11.52	12.86	12.53	13.87	11.25	13.98	12.81	9.69	6.63	5.64	7.95	141.32	10.87
	Cultivated 1″	2	13.19	12.51	11.50	12.57	12.96	14.22	13.03	13.94	12.39	11.47	6.57	7.64	9.95	151.94	11.69
	Cultivated 2″	3	14.57	13.63	12.57	13.07	13.63	14.29	12.85	14.10	12.56	11.76	9.12	8.20	10.80	161.15	12.39
	Cultivated 4″	4	14.79	13.95	12.50	12.95	13.50	14.23	13.00	14.51	12.75	12.51	9.89	9.68	10.45	164.71	12.67
	Cultivated 6″	5	13.71	13.03	11.57	12.75	13.15	13.82	12.40	13.17	12.39	11.70	9.09	8.65	9.97	155.40	11.95
	Cultivated 2″, lime	6	14.81	14.25	15.99	16.11	14.98	15.49	12.78	14.98	13.00	12.34	8.98	8.13	10.33	172.17	13.24
	Cultivated 2″, exc	7	15.64	14.40	13.11	13.22	13.89	14.79	13.08	14.41	12.76	12.10	9.13	8.39	10.05	164.97	12.67
	Cultivated 2″, exc., lime	8	15.31	14.36	13.07	13.41	13.91	14.69	13.03	13.90	13.47	11.50	8.65	8.05	10.30	163.65	12.58
	Not cultivated	9	9.54	12.19	11.15	11.95	16.01	20.57	18.10	20.58	19.17	15.03	8.98	8.30	10.06	181.63	13.97
	Cultivated 2″	10	12.88	16.79	14.84	15.09	18.24	21.46	18.59	21.88	19.93	15.53	11.31	10.21	11.09	207.84	15.98
1580	Not cultivated	11	12.91	16.36	15.03	16.16	18.94	25.43	20.46	26.92	22.34	16.84	13.38	12.72	14.97	232.46	17.88
	Cultivated 2″	12	13.39	19.65	16.89	17.77	22.68	26.58	22.97	27.03	22.88	19.85	14.69	13.40	15.61	253.41	19.49
	Cultivated 4″	13	15.34	22.47	19.58	20.11	23.41	28.17	22.47	27.78	24.34	21.47	16.14	12.82	16.25	270.35	20.79
	Cultivated 6″	14	14.73	19.60	17.53	18.27	22.13	27.20	21.46	27.14	23.69	24.36	14.08	13.09	14.74	258.02	19.84
	Cultivated 2″, exc	15	14.81	22.05	19.92	20.05	23.37	27.03	23.90	26.52	23.65	20.63	15.50	14.24	15.94	267.61	20.58
	Cultivated 2″, exc	16	14.69	22.67	20.35	21.14	23.60	27.59	25.16	27.22	24.11	21.55	15.69	14.37	16.09	274.23	21.09
	Not cultivated	17	16.20	20.43	19.23	19.99	24.21	27.18	23.41	27.18	24.43	21.27	18.14	16.70	18.03	276.50	21.26
	Cultivated 2″	18	19.64	25.10	22.89	23.47	26.25	29.60	27.18	29.75	26.79	24.32	20.24	19.14	20.68	315.70	24.28
	Cultivated 2″, exc	19	19.62	25.00	22.60	23.06	25.58	26.23	25.32	28.43	24.74	22.80	18.95	17.74	19.61	299.68	23.05
3341		20	13.74	17.08	15.71	16.88	19.63	26.57	22.07	27.56	24.79	19.67	14.37	13.65	15.97	247.69	19.05
		21	15.26	20.88	17.60	18.54	23.43	28.45	24.88	28.68	24.56	20.85	15.12	14.00	15.88	268.13	20.62
		22	16.69	22.82	19.37	20.21	25.49	29.72	25.27	29.07	26.76	21.42	17.09	15.55	17.70	287.16	22.08
		23	15.64	21.88	19.33	20.07	24.30	28.52	24.48	29.26	25.89	24.58	18.43	17.22	19.00	288.60	22.19
		24	16.01	22.00	19.70	20.22	23.58	28.52	23.42	29.38	25.21	23.03	17.72	16.38	16.16	281.63	21.66
		25	16.69	24.15	22.45	23.10	25.20	28.97	25.53	28.53	24.87	23.56	18.90	17.23	20.29	299.49	23.03
		26	18.13	26.63	23.73	23.66	27.20	31.87	34.99	38.24	35.44	32.33	23.10	21.09	21.89	384.30	26.78
		27	18.84	26.19	21.63	21.84	25.51	29.80	25.44	30.73	25.84	22.99	19.51	17.51	18.71	304.54	23.42
		28	11.46	12.43	12.94	14.57	15.23	16.48	15.61	16.59	15.61	14.41	12.11	11.67	12.38	181.49	13.96
		29	13.15	12.99	12.01	12.71	13.65	15.12	13.66	13.32	13.21	12.66	10.04	9.36	10.68	162.56	12.50
		30	12.39	12.66	11.90	14.45	12.88	13.81	12.22	14.30	12.25	11.47	12.33	7.71	9.25	157.62	12.12

TABLE 9.—WATER AT ENDS OF DRY PERIODS AND WATER CAPACITY.

Lab. No.	Description of Soil.	Water Capacity.	Average Per cent Water.	Per cent of Water Capacity.	Minimum Sept. 21, 1911	Per cent of Water Capacity.	Minimum Oct. 14, 1912	Per cent of Water Capacity.
1956	Sandy soil	26.5	10.87	41.0	11.52	43.0	5.64	21.0
1577	San Antonio clay loam	34.6	13.97	40.0	11.15	33.0	8.30	24.0
1580	Houston Black clay loam	40.7	17.88	44.0	15.03	37.0	12.72	31.0
3335	Houston Black clay	43.8	21.26	49.0	19.23	44.0	16.70	38.0
3341	Yazoo clay	45.0	19.05	42.0	15.71	35.0	13.65	30.0
3333	Houston loam	28.2	13.96	50.0	12.94	46.0	11.67	41.0
	Average	36.5	16.17	44	14.27	40.0	11.45	31.0

Table No. 9 shows the water content of the various soils at the ends of dry periods, the average content and the minimum in 1911 and the minimum in 1912 being given. The average of the periods ranges from 40 to 50 per cent. of the water capacity, or, on an average, 44 per cent. of the water capacity for all soils. The minimum of 1911 ranges from 33 to 46 per cent. of the water capacity, or an average of 40, which is only 4 per cent. below the minimum average for all. The season of 1912, however, was decidedly dry and the minimum ranges from 21 to 41 per cent. of the water capacity, the average being 31. It will be noticed that soils Nos. 1956 and 1577 dried out to a much greater extent than the others, which appear to have been much more retentive of water. All of this table refers to the uncultivated soils.

TABLE 10.—AVAILABLE WATER AT ENDS OF DRY PERIODS.

Lab. No.	Description of Soil.	Wilting Point.	Average		Maximum Sept., 1911		Maximum Oct., 1912.		Bu. Corn Possibility of Oct., 1912
			Total.	Available.	Total.	Available.	Total.	Available.	
1956	Sandy soil	1.9	10.9	9.0	11.5	9.6	5.7	3.8	4.0
1577	San Antonio clay loam	4.7	14.0	9.3	11.2	6.5	8.3	3.6	3.8
1580	Houston black clay loam	6.8	17.9	11.1	15.0	8.2	12.7	5.9	6.1
3335	Houston black clay	7.9	21.3	13.4	19.2	11.3	16.7	8.8	9.1
3341	Yazoo clay	8.3	19.1	10.8	15.7	7.4	13.7	5.4	5.6
3333	Houston loam	2.5	14.0	12.5	12.9	10.4	11.8	9.3	9.7
	Average	5.4	16.2	11.02	14.3	8.9	11.5	6.1	6.4

Table No. 10 shows the available water at the ends of the dry periods in the uncultivated soils. The average available water ranges from 9 to 13.4 per cent. The minimum available water in 1911 ranges from 6.5 to 11.3 per cent. Soils No. 3333, Houston black clay, and No. 3335, Houston loam, were the most retentive of moisture. The minimum in 1912 ranged from 3.6 to 9.3 per cent. of available water. This is a very low minimum and shows that the soils have dried out very thoroughly. Soils No. 3335 and No. 3333 were still the most retentive of moisture.

EFFECT OF TREATMENT UPON THE WATER CONTENT OF THE SOIL IN DRY PERIODS.

Table No. 11 shows the average water content of the soils at the ends of the dry periods, including all of the pots with the various treatments, the treatment being indicated by the symbols at the head of the column.

TABLE 11.—AVERAGE WATER CONTENT AT ENDS OF DRY PERIODS.

Lab. No.	Description of Soil.	Not Cultivated.	Cultivated 1″	Cultivated 2″	Cultivated 4″	Cultivated 6″	Cultivated 2″, lime.	Cultivated 2″, exc.	Cultivated 2″, exc.	Cultivated 4″, exc.	Cultivated 2″, 1 1-2″ exc.
1956	Sandy soil	10.87	11.69	12.39	12.67	11.95	13.24	12.67	12.58	....	....
1577	San Antonio clay loam	13.97	....	15.98	....	....	....	....	....	....	....
1580	Houston black clay loam	17.88	....	19.49	20.79	19.84	....	20.58	21.09	....	....
3335	Houston black clay	21.26	....	24.28	....	....	....	23.05	....	....	....
3341	Yazoo clay	19.05	20.62	22.08	22.19	21.66	....	23.03	....	26.78	23.42
3333	Houston loam	13.96	....	12.50	....	....	12.12	....	....	....	....
	Average	17.26	....	19.56	....	....	....	19.83	....	....	....
	Average except 1577 and 3333										

Cultivation to the depth of one inch increased the water content of both of the soils subjected to this treatment.

Cultivation to the depth of two inches increased the water content of the soil at the ends of the dry periods on five of the six soils in this experiment. The average increase is 2.3 per cent. This is equal to about .62 inches of rainfall saved over the untreated soil, or a quantity of water sufficient for 2.4 bushels of corn. This, however, does not represent the entire saving by cultivation.

The cultivation to the depth of four inches also increased the quantity of water held, over both the uncultivated pots and the pots cultivated to the depth of two inches, on the three soils subjected to this treatment. The difference, however, is slight. The stirred portion of the soil probably dried out, and as four inches of dry soil would be a considerable proportion of the soil in the can, we should judge that the water content of the unstirred soil is considerably larger than that in the soil stirred to the depth of two inches, the difference being greater than the amount expressed in our figures, on account of the drying out of the four inches of stirred soil.

The soil stirred to the depth of six inches contained less water than that stirred to the depth of two inches, but the stirring saved some water. As the six-inch layer was undoubtedly drier than the remainder of the soil, the content of the unstirred soil must be decidedly higher than the figures presented.

The addition of lime increased the water content over the soil stirred to the depth of two inches, in one case quite decidedly, and in the other case not at all.

The addition of excrement increased the water content of the soil over the soil stirred two inches in three of the four soils to which it was applied. In one case there was a decrease. Lime and excrement was little more beneficial than excrement alone in one case and more so in another case. The addition of excrement and stirring to the depth of four inches increased the water content over the soil stirred to the depth of four inches very decidedly in the case of soil No. 3331. The larger addition of excrement increased the water content slightly over the regular quantity applied.

Table No. 12 shows the minimum water content of the soils at the ends of the dry periods of 1911 and 1912.

TABLE 12.—MINIMUM AVAILABLE WATER AT ENDS OF DRY PERIODS.

Lab. No.	Minimum of Sept. 21, 1911.	Wilting Point.	0″	1″	2″	4″	6″	2″ Lime.	2″ Exc.	Exc.	4″ Exc.	2″ 1½ exc.
1956	Sandy soil	1.9	9.6	9.6	10.7	10.6	9.7	13.1	11.2	11.2		
1577	San Antonio clay loam	4.7	6.5		10.2							
1580	Houston black clay loam	6.8	8.2		10.1	12.8	10.7		13.1	13.6		
3335	Houston black clay	7.9	11.3		15.0				14.7			
3341	Yazoo clay	8.3	7.7	9.3	11.1	11.0	11.4		14.2		15.4	13.3
3333	Houston loam	2.5	10.4		9.5			9.4				
	Average		8.9		9.5							
	Minimum of Oct. 14, 1912.											
1956	Sandy soil	1.9	3.7	5.7	6.3	7.8	6.8	6.2	6.5	6.2		
1577	San Antonio clay loam	4.7	3.6		5.5							
1580	Houston black clay loam	6.8	5.9		6.6	6.0	6.3		7.5	7.6		
3335	Houston black clay	7.9	8.8		11.2				9.8			
3341	Yazoo clay	8.3	5.4	5.7	7.3	8.9	8.1		8.9		12.8	9.2
3333	Houston loam	2.5	9.2		6.9			5.2				
	Average		5.2		6.2							

With the exception of soil No. 3333, Houston loam, stirring to the depth of two inches saved quite a decided quantity of water during both of the dry periods. Stirring to the depth of four inches is in one case in 1911 more beneficial than two inches, and in two instances in 1912, three soils being cultivated in this way. The soil on which it had a beneficial action in 1911 did not show the beneficial action in 1912. Stirring to the depth of six inches is less effective than stirring to the depth of four inches. The addition of lime was beneficial in one of the two cases in 1911, but not in 1912. The addition of excrement was beneficial in three of the four cases in 1911, and in 1912, soil No. 3335, Houston black clay, in each year showing little benefit. Lime and excrement are no more beneficial than excrement alone in the two cases. Four inches stirring with the excrement added is more beneficial than the four inches alone in both years.

Table 13 shows the gain of available water as expressed in bushels of corn or pounds of cotton per acre.

TABLE 13.—GAIN OF AVAILABLE WATER BY CULTIVATION TWO INCHES, EXPRESSED IN CORN AND COTTON.

Lab. No.	Description of soil,	Corn (Bushels)			Cotton (Pounds)		
		Average	Minimum 1911	Minimum 1912	Average	Minimum 1911	Minimum 1912
1956	Sandy soil	0.5	1.1	2.5	7	14	33
1577	San Antonio blay loam	2.0	3.7	1.9	26	48	25
1580	Houston black clay loam	1.6	1.9	0.7	23	35	9
3335	Houston black clay	3.0	3.7	2.4	39	48	31
3341	Yazoo clay	3.0	3.4	1.9	39	44	25
3333	Houston loam	0	0	0	0	0	0

The gain in 1911 varies from 0 to 3.7 bushels of corn, and in 1912, from 0 to 2.5 bushels. The gain of cotton lint varies from 0 to 48 pounds in 1911, and 0 to 33 pounds lint in 1913.

These gains are the differences in water content due to cultivation of the soils. As, however, the gains are continuous from day to day, and the differences are from time to time equalized, at least to a certain extent, by rainfall, the actual gain would be really much larger than is expressed by the above figures.

According to the results secured in Bulletin No. 171, with the percolation apparatus, cultivation was much more effective in retaining water and decreasing percolation in the sandy soils than in the clay soils.

According to the work here reported, cultivation decreased evaporation in all the soils. We have not yet decided on the explanation of the discrepancy. Most of the percolation takes place during wet periods. The percolation should depend to a certain extent, upon the extent of drying out during the previous dry period. It also depends, however, upon the rapidity of penetration through the soil, as a saturated soil loses water much more rapidly than a soil that is not saturated. The clay soils have a tendency to crack during dry periods, fissures being produced which allow the water to penetrate rapidly. This fact may affect the percolation decidedly; the rate of penetration of the water may affect the total percolation.

LOSSES OF MOISTURE.

Table No. 14 shows the losses of moisture from the pots during the various dry periods with the exception of September 21 to October 9, and October 9 to December 5, when there were gains due to the water falling during these periods. These losses represent the loss by evaporation and not the loss by percolation, as they are based entirely upon the weight of the pots. Table 15 shows the gains during the various wet periods with the exception of the period ending July 25 to March 30, when there were losses. These were not included in the average, but are placed at the bottom of the table.

TABLE 14.—LOSSES OF MOISTURE IN PERCENTAGE OF THE SOIL.

	Soil 1956								Soil 1577	
	1 0″	2 1″	3 2″	4 4″	5 6″	6 Lime 2″	7 2″ Exc.	8 1″ Exc.	9 0″	10 2″
May 3 to June 29	9.29	5.61	5.09	4.68	1.87	5.17	5.17	5.58	15.46	10.92
July 20 to Aug. 10	2.66	2.30	1.72	1.45	1.75	6.68	1.74	1.67	7.70	4.45
Aug. 10 to Sept. 21	.17	1.01	1.06	1.45	1.46	+1.74	1.29	1.29	1.04	1.95
Jan. 9, 1912	.78	.82	.84	.78	1.03	.95	.90	.95	1.41	1.77
Jan. 9 to Feb. 12	2.62	1.19	1.44	1.23	1.42	2.71	1.71	1.66	2.47	2.87
May 6 to May 30, 1912	.65	1.08	.69	.11	1.49	.54	.57	1.03	1.25	.50
May 30 to June 13	1.17	1.55	1.54	1.76	.78	1.98	1.65	.43	1.41	1.95
June 13 to July 15	2.12	.92	.80	.24	.69	.66	.66	1.97	4.14	4.40
July 20 to Sept. 16	7.34	7.80	5.45	4.68	5.12	6.26	5.28	5.73	11.98	10.30
Sept. 16 to Oct. 14	.99	+1.07	.92	.21	.44	.85	.74	.60	.68	1.10
Oct. 18 to Nov. 19	3.85	2.42	1.27	2.37	2.43	2.21	4.37	1.88	6.67	3.76
Total	31.64	23.63	20.82	18.96	18.48	26.27	24.08	22.79	54.21	43.97
Average	2.88	2.36	1.89	1.72	1.68	2.63	2.19	2.07	4.93	4.00

TABLE 14.—LOSSES OF MOISTURE IN PERCENTAGE OF THE SOIL—Continued.

	Soil 1580						Soil 3335		
	11 0″	12 2″	13 4″	14 6″	15 2″ Exc.	16 2″ Exc.	17 0″	18 2″	19 2″ Exc.
May 3 to June 29	17.55	16.15	15.08	16.00	14.87	15.23	13.06	11.89	9.52
July 20 to Aug. 10	7.92	5.34	4.69	7.27	4.25	4.06	5.48	4.84	4.27
Aug. 10 to Sept. 21	1.33	2.76	2.91	2.07	2.13	2.32	1.20	2.21	2.40
Dec. 27 to Jan. 9, 1912	1.92	1.62	2.65	2.47	2.05	.07	1.70	1.43	3.76
Jan. 9, 1912 to Feb. 12	4.97	3.59	5.68	5.74	3.13	2.43	3.77	2.47	.91
May 6 to May 30	1.23	1.42	1.15	1.50	2.50	2.15	1.01	.19	+ .63
May 30 to June 13	4.58	4.15	3.44	3.45	2.87	3.11	2.75	2.96	3.69
June 13 to July 15	5.50	3.03	2.87	+ .67	2.02	2.56	3.16	2.47	1.94
July 20 to Sept. 16	9.84	11.37	11.86	13.01	11.33	11.86	8.12	9.48	9.75
Sept. 16 to Oct. 14	.66	1.29	3.32	.99	1.26	1.32	1.44	1.10	1.21
Oct. 18 to Nov. 19	3.35	3.80	3.77	4.31	3.93	3.90	3.55	3.64	3.47
Total	58.85	54.52	57.42	56.14	50.34	49.01	45.24	42.68	40.29
Average	5.35	4.95	5.22	5.10	4.58	4.45	4.11	3.88	4.09

TABLE 14.—LOSSES OF MOISTURE IN PERCENTAGE OF THE SOIL—Continued.

	Soil 3341								Soil 3333		
	20 0″	21 1″	22 2″	23 4″	24 6″	25 2″ Exc.	26 2″ Exc.	27 4″ Exc.	28 0″	29 2″	30 2″ Ca.
May 3 to June 29, 1911	17.61	16.07	17.32	15.37	16.41	11.84	19.23	10.75	7.43	5.08	3.17
July 20 to Aug. 10	7.50	6.23	5.49	6.28	5.47	4.32	4.25	3.79	3.56	2.02	1.81
Aug. 10 to Sept. 21	1.37	3.28	3.45	2.55	2.30	1.70	2.90	4.56	+ .31	.98	.76
Dec. 27 to Jan. 9, 1912	1.83	1.84	1.48	2.08	.60	2.03	1.13	2.38	.99	1.42	1.37
Jan. 9 to Feb. 12	4.50	3.57	4.45	4.04	5.10	3.46	+3.12	4.36	.87	1.46	1.59
May 6 to May 30	1.10	1.99	2.76	1.30	.37	1.53	2.88	+ .22	1.20	1.75	.77
May 30 to June 3	2.77	4.12	2.31	3.37	4.17	3.66	2.80	4.89	.98	.11	2.05
June 3 to July 15	5.12	3.71	5.34	1.31	2.18	1.31	3.11	2.85	1.20	.55	.78
Sept. 16 to Oct. 14	.72	1.12	1.54	1.21	1.34	1.67	2.01	2.00	.44	.68	4.62
Oct. 18 to Nov. 19	3.31	3.34	3.07	4.36	3.05	4.58	4.68	3.86	2.58	3.51	3.41
Total	45.83	45.27	47.21	41.87	40.99	36.10	39.87	39.22	18.94	17.56	20.33
Average	4.58	4.53	4.72	4.18	4.10	3.61	5.54	4.36	2.10	1.75	2.03

TABLE 15.—GAINS OF MOISTURE IN PERCENTAGE OF THE SOIL.

	Soil 1956								Soil 1577	
	1 0″	2 1″	3 2″	4 4″	5 6″	6 Lime 2″	7 2″ Exc.	8 2″ Exc.	9 0″	10 2″
June 29 to July 10	3.02	1.51	.89	.72	1.12	4.55	.61	.83	4.75	5.05
Dec. 5 to Dec. 27	2.12	2.08	1.50	1.51	1.70	1.46	1.80	1.73	5.97	4.99
Feb. 12 to March 11	2.96	1.62	1.72	1.45	1.98	2.71	1.66	1.66	3.33	3.32
May 6	.59	.77	.39	.50	.84	.42	.69	.40	.28	.16
July 15 to July 20	4.28	2.90	2.81	2.06	2.51	2.90	2.31	2.88	5.93	6.08
Oct. 14 to Oct. 18	6.16	5.73	3.87	3.14	3.75	4.41	6.03	4.13	8.43	4.64
Nov. 19 to Dec. 13	5.37	3.29	2.55	3.02	3.63	3.31	3.16	3.02	10.02	9.07
Total	24.50	17.90	13.73	12.40	15.53	19.76	16.26	14.65	38.71	33.31
Average	3.50	2.56	1.96	1.77	2.22	2.82	2.34	2.09	5.53	4.76

TABLE 15.—GAINS OF MOISTURE IN PERCENTAGE OF THE SOIL—Continued.

	Soil 1580						Soil 3335		
	11 0″	12 2″	13 4″	14 6″	15 2″ Exc.	16 2″ Exc.	17 0″	18 2″	19 2″ Exc.
June 29 to July 10	6.03	5.18	5.10	5.20	5.64	5.32	4.62	4.94	5.37
July 10 to July 20	5.36	6.42	6.74	7.14	5.85	6.72	5.09	4.26	4.28
Dec. 4 to Dec. 27	8.41	5.52	7.41	7.54	5.71	4.06	4.67	4.23	4.41
Feb. 12 to March 11	7.16	4.60	5.69	6.01	4.05	3.50	4.27	2.92	2.94
March 30 to May 6	.73	1.06	.66	.51	1.46	.91	.57	—.30	—.63
July 15 to July 20	6.38	6.21	6.53	2.73	6.20	6.00	4.99	5.40	5.90
Oct. 14 to Oct. 18	5.60	6.01	7.20	5.96	5.63	5.62	4.88	5.18	5.34
Nov. 19 to Dec. 13	11.83	11.42	10.78	11.61	10.78	11.07	10.11	8.99	9.04
Total	51.50	46.42	50.11	46.50	45.32	43.20	39.20	35.62	36.65
Average	6.44	5.80	6.26	5.81	5.66	5.40	4.90	5.09	5.24
Percentage to July 10	0	0	0	0	0	0	0	.12	0
July 15–20	0	0	.10	.35	0	0	0	0	.35
Oct. 14 to Oct. 18	0	0	0	0	0	0	.36	0	0

TABLE 15.—GAINS OF MOISTURE IN PERCENTAGE OF THE SOIL—Continued.

	Soil 3341								Soil 3333		
	20 0″	21 1″	22 2″	23 4″	24 6″	25 2″ Exc.	26 2″ Exc.	27 4″ Exc.	28 0″	29 2″	30 2″ Ca.
June 29 to July 10	5.50	5.15	5.56	5.37	5.07	5.63	4.38	5.31	4.26	1.92	1.86
July 10 to July 20	5.34	6.70	6.06	7.15	6.39	6.15	7.37	5.83	.27	—.06	.22
Dec. 4 to Dec. 27	8.77	6.96	5.81	6.30	5.54	5.82	6.80	7.67	2.24	2.89	2.30
Feb. 12 to March 11	5.94	4.50	5.43	5.32	6.09	4.05	—3.12	4.63	1.58	2.72	2.08
March 30 to May 6	.98	1.62	1.69	.43	—1.54	.74	—.82	.10	.54	—.22	—.05
July 15 to July 20	5.61	5.93	7.43	5.12	5.47	6.06	—2.29	6.54	2.73	5.57	3.10
July 20 to Sept. 16	10.91	11.66	1.76	11.27	10.78	10.72	6.94	10.02	5.03	8.19	2.24
Oct. 14 to Oct. 18	5.63	5.22	5.22	6.14	2.83	7.64	5.48	5.06	3.29	4.83	4.95
Nov. 19 to Dec. 13	12.81	12.80	11.37	10.16	11.33	8.90	8.67	10.58	3.83	6.92	4.23
Total	61.49	60.54	50.33	57.26	53.74	55.71	33.41	55.74	23.77	32.76	20.93
Average	6.83	6.93	5.59	6.36	6.49	6.19	5.57	6.19	2.64	4.68	2.61
Percentage to July 10	0	0	0	0	0	0	0	0	.44	2.92	2.92
July 15–20	0	0	0	1.36	.43	.36	.56	.51	2.88	.72	3.08
Oct. 14 to Oct. 18	0	0	0	0	0	0	0	0	1.12	.20	0

The effect of the cultivation is, on an average, to decrease the loss of moisture by evaporation during the periods. This is shown by considering the average results given in the table. Two-inch cultivation is effective in this respect in every case with the exception of soil No. 3341. With this soil, on an average, a two-inch cultivation shows a higher loss than the pot without cultivation.

If we study the table in more detail we find that the cultivation does not always save the water of the soil. For example, in the period from August 10 to September 21, there is a greater loss from the cultivated soils than from the uncultivated in every case. The same thing occurs with soil No. 1956 in a period from May 30 to June 13 with the exception of the soil cultivated to the depth of six inches, and also with soil No. 1577, but with the other soils the loss is less from the uncultivated soils, with some exceptions.

The gains from the soils are in an opposite direction from the losses. That is to say, the cultivated soils having lost less moisture during the dry season, also gained less moisture during the subsequent wet season. This rule does not follow in all cases. For example, in the period ending July 20, there is a greater gain with the cultivated soils, Nos. 1580, 3335, and 3341, than with the uncultivated.

This relation of the losses to the gains is to be expected, as the soil when saturated holds almost the same quantity of water whether cultivated or uncultivated, although, as we have seen, there are some differences.

WATER CONTENT OF THE SOIL TYPES.

There is a decided variation in the water condition of the various soil types. The calculated available water of the saturated soils varies from 12.0 to 18.2 per cent. (Table 6), or about 50 per cent. The average calculated available water of the soils at the ends of the dry periods varies from 9.0 to 13.4 per cent. (Table 10), or about 50 per cent. The variation is still more for the minimum dry points of 1911 and 1912. The clay soils throughout are more retentive of moisture and for this reason have a higher crop possibility when other conditions are good. On the other hand, they are more liable to suffer from excess of moisture during prolonged wet periods.

ACKNOWLEDGMENT.

Weighing and other work connected with the bulletin were made by Mr. W. C. Hamner, J. B. Kelly, J. B. Rather, L. C. Ludlum, A. J. Weaver, and perhaps other members of the staff.

SUMMARY AND CONCLUSIONS.

1. This bulletin reports a study of the moisture content of six Texas soils, under different conditions and treatment, for two years.
2. Curves are given showing the moisture content of the soil at different periods and the relation of the moisture to the rainfall.

3. The average quantity of water after continued rains is 58 per cent. of the water capacity measured in the laboratory, and the maximum quantity is 69 per cent.

4. The soils retained when saturated to a depth of 14 inches enough water for 12.6 to 19.1 bushels of corn, or from 156 to 234 pounds of lint cotton. The crop draws upon a greater depth of soil for moisture, but there are also great losses due to evaporation.

5. Cultivation and manure both increase the quantity of water held at the ends of the wet periods.

6. The soils retained at the ends of the dry periods, on an average of the two years, 44 per cent. of the water capacity measured in the laboratory. The lowest quantities reached in 1911 were 33 to 46 per cent. of the water capacity; in 1912, from 21 to 41 per cent.

7. Cultivation increased the water content of the soils at the ends of the dry periods.

8. Excrement also increased the water content of the soils at the ends of the dry periods.

9. Cultivation and manure decrease the loss by evaporation.

10. There are decided variations in the capacity of the various soils to hold water during wet periods and to retain water during dry periods. There is a variation of about 50 per cent. in the soils studied.